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Why Don=t We Know More About Housing Supply?

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Virtually every paper written on housing supply begins with some version of the same sentence: While there is an extensive literature on the demand for housing, far less has been written about housing supply. Although this statement is clearly true, at this point, there have actually been a considerable number of papers on housing supply. However, the empirical evidence on the supply of housing is far less convincing than that on the demand for housing. Why don=t we know more about housing supply?

Because housing is a durable good, housing supply is determined not only by the production decisions of builders of new units but also by the decisions made by owners of housing (and their agents) concerning conversion of the existing stock of housing. Owners can convert two units into one or convert a large single family Victorian home into several small apartments. Owners may decide to rehabilitate an existing unit to increase the flow of housing services being delivered by that unit or decrease maintenance of an existing unit, decreasing the flow of housing services. These adjustments to the existing stock are significant. In 1995, expenditures on maintenance, repair, improvements and alterations of the housing stock totaled $111.7 billion; expenditures on private construction of new residential buildings totaled $162.4 billion.[1] Baer (1986) argues that while new construction is the main source of additions to the housing stock, the share of additions to the stock that come from improvements to the existing stock has increased over time, rising from roughly 10% of total additions during the 1950s and 1960s to about 27% between 1973 and 1980.

In addition, government policy can have a profound impact on the operation of the housing market. Rental assistance such as vouchers or subsidies to homeowners in the form of the mortgage interest deduction increase demand for housing services. The long run impact on

[1] Bureau of the Census, Construction Reports, Series C-50 and Series C-30, respectively.

price depends on the supply response determined by the price elasticity of supply. Government policy has also impacted the supply side of the market directly through the construction of public housing and tax policy designed to encourage the private construction of new rental housing. These interventions raise an important policy question concerning the extent to which these policies result in net additions to the housing stock or simply crowd out private activity.

As Quigley (1979) points out, there are real analytical difficulties for modeling supply. First, while thinking about housing supply as the flow of housing services provided is conceptually very pleasing, housing services are difficult to measure. Unlike other markets where we observe price per standard unit (e.g., price per pound of apples), in the housing market, we observe housing expenditures (price times quantity) and there is no standard housing quantity since each unit can vary considerably on many quality dimensions. Of course, this is a problem in studying housing demand as well.

Second, housing supply is the outcome of complicated decision making by builders and the owners of existing housing. However, we have little direct evidence that permits us to observe the behavior of housing suppliers. In order to understand the micro foundations of housing supply, we would ideally want data in which the unit of observation is the supplier, with information on the quality and quantity of housing services offered, maintenance and capital improvement decisions, rents, and asset values. In the case of new supply, there is no standard data set that permits us to observe the behavior of builders of new housing. In the case of conversion of the existing housing stock, various household surveys such as the American Housing Survey provide information on the renovation and repair decisions of owner-occupants. There is no standard data set that permits us to observe the behavior of investors in rental housing. This remarkable lack of information on the major actors in housing supply presents a

significant obstacle to increasing our understanding of housing supply. More effort needs to be made in building new datasets that permit observation of the behavior of these important actors.

In this paper, I attempt to summarize what we do know about housing supply and outline a research agenda. My main focus is on the empirical work on housing supply although the theoretical motivation for the empirical work is discussed as well. The intent of this paper is not to provide an exhaustive review of every paper written on supply but to focus the discussion on the main issues addressed in this literature.

Table 1 provides a way of classifying the empirical literature that is reviewed in this paper. The focus of this work is either on the supply of new housing or on the renovation and repair of the existing stock. The empirical approach either employs aggregate data at the national or metro level or micro data where the decision-maker (i.e., builder or owner) is the unit of analysis. While the papers categorized in Table 1 are not intended to reflect the entire literature on housing supply, they do indicate the prevalence of the various approaches. Virtually all of the studies of new housing supply analyze aggregate data. It is surprising that I found no study of renovation and repair that employed aggregate data. At the national level at least, there is a long time series reflecting this investment; these data could certainly be used to explore macro trends in renovation and repair.[2] Micro data dominate the studies of renovation and repair. Bogdon (1992) and Montgomery (1992) employ the American Housing Survey, Potepan (1989) uses the Panel Study of Income Dynamics, Gyourko and Linneman (1990) use the New York City Housing and Vacancy Survey, and Rydell (1982) is based on data from the Housing Assistance Supply Experiment.

[2] The C50 series in *Current Construction Reports* provides expenditures on residential improvements and repairs quarterly from 1962. Of course, the series measures expenditures, which can be problematic, since they reflect price times quantity rather than just the quantity of additions to the stock.

TABLE 1 Selected Housing Supply Literature

	Aggregate Data	Micro Data
New Housing Supply	Muth (1960), DeLeeuw and Ekanem (1971), Follain (1979), Murray (1983, 1994), Poterba (1984), Stover (1986), Topel and Rosen (1988), DiPasquale and Wheaton (1992, 1994), Follain, Leavens, Velz (1993), Malpezzi and Maclennan (1996), Mayer and Somerville (1996)	Rydell (1982) Rosenthal (1995)
Renovation and Repair		Rydell (1982), Potepan (1989), Gyourko and Linneman (1990), Bogdon, (1992), Montgomery (1992)

In the next section of this paper, the determinants of new housing supply and the long run price elasticity of supply are explored. In Section III, I discuss the determinants of renovation and repair decisions followed by an examination of the impact of government policy on housing supply. The paper concludes with a summary of what we know about housing supply and suggestions for future research.

Determinants of New Housing Supply

In the literature, there are two basic approaches to estimating housing supply: reduced form estimation where generally price is a function of supply and demand factors, and more structural approaches where aggregate supply is estimated directly with construction as a function of price and cost shifters.[3] Much of the early literature focused on the reduced form approach and a major goal of this work was to estimate the price elasticity of supply.

[3] There were also important early industry studies of homebuilding that explored the costs that impact builders decisions. Maisel (1953) provides a detailed description of builders of single family housing in the San Francisco area and the factors that influence their construction decisions.

In one of the earliest empirical studies of housing supply, Muth (1960) regresses the price of housing on output and other supply and demand factors and finds no statistically significant relationship between output and price. This is evidence of perfectly elastic supply. He then reverses the model with output as the dependent variable and price and other explanatory variables on the right hand side and finds no statistical relationship between price and output. As Stover (1986) points out, this is evidence of perfectly inelastic supply. Follain (1979), using more recent data, estimates similar models yielding the same results. Both Muth and Follain conclude that supply is totally elastic. As Stover (1986) argues, given the contradictory evidence of the results, there is no reason to conclude from these studies that the supply curve is flat. He also argues that Muth and Follain use national data, which might give rise to aggregation bias. He estimates a translog cost function using cross-section data from 61 metropolitan areas. Stover=s estimates are consistent with an infinite supply elasticity.

DeLeeuw and Ekanem (1971) examine the supply of rental housing services. They estimate a reduced form equation explaining the variation in the BLS quality controlled rent index (rent per unit of housing services) across 39 metropolitan areas with the price of capital inputs, price of operating inputs, income and the stock of households. Their estimates of the elasticity of the supply of housing services with respect to price per unit of services range from 0.3 to 0.7.

Olson (1987) points out that a reduced form equation in DeLeeuw and Ekanem, where price is the dependent variable and output quantity and input prices are included on the right hand side, is a misspecification, making the results difficult to interpret. He argues that if the relationship between price and input prices is correctly specified then the coefficient on quantity is zero regardless of the elasticity of supply. As a result, the supply function with price as the

dependent variable should have either input prices or quantity on the right hand side but not both. Since the goal of the analysis was to examine the relationship between long-run supply price and output, DeLeeuw and Ekanem should not have included input prices in their estimation. Other reduced form studies such as Muth (1960) and some specifications in Follain (1979) present the same problem. Malpezzi and Maclennan (1996) estimate a reduced form equation taking this point into account; housing quantity is on the right hand side but input prices are not. They estimate supply elasticities for the U.S. that range from 4 to 13 depending on specification.

In the last decade, there have been several attempts to directly model housing supply. The theoretical underpinnings of much of this literature come from one of two sources: the investment literature or the literature on urban spatial theory. The main difference in these two approaches is the treatment of land as an input in the production of new housing. Those studies based on the investment literature tend to ignore the unique characteristics of land as a factor of production, while those based on urban spatial theory explicitly incorporate the land market into the theoretical structure.

Poterba (1984) takes an asset market approach to modeling the housing market. His model of the housing market examines the impact of a shock to the steady state, mapping out the adjustment process to a new steady state. A shock such as a decline in user cost results initially in an increase in real housing price since the housing stock is fixed. The market then adjusts with growth in the housing stock and a decline in real price to a new steady state. On the supply side, he assumes that the homebuilding industry is composed of competitive firms[4] and that the industry=s aggregate supply depends on its output price, the real price of housing structures. Assuming there are limits to supply of any factor of production (e.g., lumber), increases in

[4] Rosenthal (1995), using a unique and rich data set on single family homes in Vancouver, British Columbia, shows that homebuilding is competitive with little opportunity for builders to generate

demand for construction increase the equilibrium price of structures. Poterba defines supply as net investment in structures, ignoring land; he acknowledges the importance of land but omits land because of the data issues for his empirical work.

Poterba=s empirical model has net investment in structures as a function of real house prices, the price of the output alternative, in this case measured by the nonresidential construction deflator, construction costs measured by real construction wages, and net deposit inflows into savings and loan institutions as a measure of credit availability. The estimates indicate that the price of housing is the major determinant of new construction. Across the model specifications presented, the estimated elasticities of new construction with respect to real house price range from 0.5 to 2.3. As expected, an increase in the price of non-residential construction decreases investment in residential structures and an increase in deposits to S&Ls increases residential investment. Real construction wage generally has the wrong sign and is not statistically significant. As indicated below, much of the empirical work on housing supply share the problem of poor performance of various measures of construction cost.

Topel and Rosen (1988) examine the extent to which housing investment decisions are determined by comparing current asset prices with current marginal costs of production. They argue that current asset prices are sufficient statistics for housing investment if short-run and long-run investment supply are the same. If changes in the level of construction activity impact the cost of production, then supply is less elastic in the short run than the long run. This divergence between short term and long term elasticities indicates that current asset prices are not sufficient and builders must form expectations about future prices in order to make investment decisions.

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excess profits.

In their empirical work, Topel and Rosen estimate a supply function where quarterly single family housing starts are a function of real house prices and a vector of cost shifters. They estimate a basic myopic model and then a model with expectations and internal adjustment costs. Their results reject the myopic model. They estimate a long run supply elasticity of about 3.0 and a short run elasticity of around 1.0. However, their results also indicate convergence between the two within a year. They argue that this rapid convergence is due to the fact that resources in the construction industry are not all that specialized and can be quickly assembled under changing market conditions.

The cost shifters in the Topel and Rosen models present some puzzling results. Like Poterba (1984), none of their measures of construction costs have a significant impact on starts. Real interest rates are included to reflect the cost of capital to builders. However, Topel and Rosen find that real interest rates and expected inflation have a large and significant impact on construction. They argue that the magnitude of the coefficient on real interest rates is too large to simply reflect the cost of capital to builders and that the impact of inflation is difficult to explain. They posit that the impact of inflation may reflect changes in the speed at which homes are sold at current market prices. To test this notion, they include the median months on the market for new homes and again find a large, negative and significant impact. Topel and Rosen argue that the effect is too large to simply reflect holding costs associated with sales delays; the magnitude is difficult to explain.

The investment-based models of Poterba and Topel and Rosen do not account for perhaps the most unique aspect of housing--the importance of land as an input. The models based on the investment literature assume that the homebuilding industry is composed of competitive firms that face rising factor cost schedules for labor and building materials. In the short run, rising

costs result from bottlenecks and in the long run from increasing supply schedules for labor and building materials. In DiPasquale and Wheaton (1994), we argue that the implication of this view is that a long run increase in house prices leads to a permanent increase in the flow of construction; the magnitude of this increase depends on how much factor costs increase with an increase in building activity.

Land is fundamentally different from other factors. As indicated in the extensive literature on urban spatial theory, land prices depend on the stock of housing, not the flow or level of building activity. As a result, a rise in house prices initially generates excess returns, but the flow of construction increases only temporarily above some normal level. As the stock of units grows, land prices rise and eventually absorb the excess returns and construction declines to its normal level.

Urban spatial theory provides equilibrium models in which the stock of housing always equals the urban population. In these models, there is no supply theory dealing with construction flows since new construction or the flow of housing simply equals the growth in population. In DiPasquale and Wheaton (1994), we propose a simple model of housing construction combining a stock adjustment process with a long run spatially-based definition of the equilibrium housing stock. In this model, price levels and cost shifters determine the long run equilibrium stock. Housing price levels generate new construction only if those prices dictate a level of the stock that is higher than the current level. This model yields a construction equation where new construction is a function of price levels, cost shifters, and the lagged stock.

The basic supply model estimated in DiPasquale and Wheaton has single family housing starts as a function of current housing prices, real short term interest rates as a measure of the cost of capital to builders, land costs as measured by the price of agricultural land, construction

costs measured as a weighted average of labor and material costs, and the stock of housing in the previous period. Price has the expected positive sign. Estimates of the price elasticity of the desired stock range from 1.2 to 1.4; estimates of the price elasticity of construction range from 1.0 to 1.2. The results indicate that the stock adjusts to its new long run equilibrium through new construction very slowly; the rate of adjustment is estimated at 2% per year, which implies that it takes 35 years to reach a new equilibrium. This estimated adjustment rate seems too slow, especially for single-family housing, which can be constructed relatively quickly. Real short-term interest rates have a significant negative impact on construction. Land costs do not have a significant impact on construction. Like Poterba and Topel and Rosen, we found no significant relationship between construction costs and the level of construction, which is surprising. Following Topel and Rosen, we add months on the market for new homes to the supply equation. We also find that sales time has a large impact on construction. Like Topel and Rosen, the magnitude of the coefficient appears too large to reflect simply holding costs from sales delay.[5] These results certainly suggest that price is not a sufficient statistic.

In a recent paper, Mayer and Somerville (1996) develop a model of residential construction based on the theory of urban land development presented in Capozza and Helsley (1989). Their model incorporates a dynamic adjustment process to account for the time it takes to go through the development process. In addition, they carefully consider the underlying time series characteristics of the data, using more sophisticated time series methods. Much of the underlying economics of the Mayer and Somerville model is similar to that presented in DiPasquale and Wheaton. However, their approach constructs a model where housing starts are a function of price and cost changes rather than levels. Mayer and Somerville argue that starts

[5] As another market indicator, we include the change in employment, which had the expected positive impact on construction. Adding the change in employment and sales time to the model

are a flow variable and therefore should be a function of other flow variables. In their model, single family housing starts are a function of current price changes and lagged price changes and current cost changes and lagged cost changes. In DiPasquale and Wheaton, price levels only generate new construction when those price levels dictate a long run equilibrium stock that is different from the current stock. Hence, construction is a function of price levels and the lagged stock. As Mayer and Somerville point out, their approach has the significant advantage of not requiring a measure of the lagged stock in each period, which DiPasquale and Wheaton estimated from the decennial census. However, the Mayer and Somerville approach is dependent on determining the appropriate lag structure.

Mayer and Somerville=s results suggest a price elasticity of starts of around 6.0 but a very low price elasticity of the stock of around 0.08. This difference between the starts and stock elasticities is large.[6] The authors argue that the low price elasticity of the stock is due to the fact that starts are a small percentage of the stock. Lagged changes of real short-term interest rates have a negative impact on starts. Again, they find that changes in construction costs are not statistically different from 0 and time to sales has a large and significant impact on construction.

Much of the literature where supply is directly estimated focuses on the single family housing starts or investment in structures. In DiPasquale and Wheaton (1992), we estimate a construction equation for multifamily rental housing where the level of new multifamily construction (units in structures with 2 or more units) depends on how the asset price of rental housing compares to the construction costs. Asset prices are a function of rents, vacancies and the capitalization rate. The estimated model explains variation in construction with rents,

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substantially improves the overall fit of the model.

[6] In DiPasquale and Wheaton, in the long run steady state where the current stock equals the long run equilibrium stock, we expect that the price elasticity of the stock should equal the price elasticity of construction.

vacancies, the capitalization rate, constructions costs, lagged construction (in case supply does not respond immediately to market changes), and construction by the federal government. From this model, we estimate a long run rent elasticity of supply of 6.8. In this model, our measure of construction costs, the cost indices constructed by the firm R.S. Means, has the expected negative impact and is statistically significant.

Follain, Leavens and Velz (1993) estimate a model of the supply of multifamily housing where permits are a function of rents, the capitalization rate, replacement cost per unit of rental housing, and lagged permits. They estimate the model using quarterly data from four metropolitan areas--Atlanta, Chicago, Dallas, and Oakland--for 1977 through 1990. Their results suggest that the long run rent elasticity is between 3.0 and 5.0.

What can we conclude from this evidence on the determinants of new supply? First, it does appear that supply is elastic with respect to price. Second, price does not appear to be a sufficient statistic; the importance of market indicators such as time to sale and inflation is difficult to explain. Third, construction levels do not seem to be impacted by construction costs, which again is counterintuitive.

The importance of market indicators such as time to sale and the unimportance of construction costs across a number of different aggregate models suggest that we do not fully understand how suppliers view the market and/or the data employed do not accurately reflect market conditions. While time series modeling based on aggregate data seems a reasonable approach to examining the determinants of new housing supply, the anomalies in the results are surprisingly consistent across the various studies undertaken. Over the past decade, there have been significant improvements in the times series methods employed in aggregate time series analyses of housing supply but these improvements have not resolved the importance of market

indicators or the unimportance of construction costs. While future time series studies of aggregate supply should employ state of the art methods to avoid specification problems, at this point, it seems unlikely that more of the puzzle of these anomalies can be unraveled with aggregate time series data at the national or metro levels.

Increasing our understanding of how suppliers view the market requires more information about suppliers and how they make decisions. We need to know more about micro foundations of supply. At this point, new data where the unit of observation is the builder or developer seems the more productive route, though clearly very labor intensive. The micro foundations of supply could lead to alternative specifications of aggregate time series models or suggest alternative measures of market conditions. The Somerville paper in this volume makes an important contribution to this effort by bringing new data to bear on construction costs. He has constructed measures of construction costs with data from a large national builder. These data diverge considerably in various local markets from the standard industry cost measures used in the studies discussed above, suggesting that at least part of the problem with construction costs is the quality of the data used.

Conversion of the Existing Stock

Clearly, a major way in which the supply of housing adjusts to changing market conditions is through the investment and maintenance decisions of owners of housing units. As discussed in the introduction to this paper, virtually all the work done on residential improvements is based on micro data. Much of the work done to date on renovation and repair decisions focuses on owner-occupied housing. The improvement decisions of homeowners are complicated by the fact that homeowners are both suppliers and consumers of housing. As a

result, much of this literature focuses on the demand for home improvement. This demand literature is relevant to any discussion of housing supply, given that a national homeownership rate of roughly 65% indicates that the renovation and repair decisions of homeowners determine the quality of a significant portion of the nation's housing stock.

Bogdon (1992) provides a detailed review of the literature on renovation and repair decisions. She argues that the basic modeling approach in this literature is to assume that the property owner is maximizing the value of the net benefits from the housing unit. For owner-occupants, the benefits include housing consumption (flow of housing services net of operating and maintenance costs) and the return on the housing investment in the form of capital gains when the house is sold. Expenditures on renovation, repair and maintenance increase with the marginal value the household places on housing services, the additional flow of services produced by the expenditures, and the expected gain when the property is sold. Bogdon=s review of the literature as well as her own results suggest that improvement expenditures are inelastic with respect to income.[7]

Potepan (1989) examines the decision between making home improvements and moving. Specifically, Potepan examines the impact of increases in interest rates and income on the choice between improving and moving. Potepan posits that higher interest rates increase the attractiveness of home improvements assuming that homes are purchased with a fixed rate mortgage. If moving results in taking a mortgage at a higher interest rate than the mortgage on the current house, the household finds home improvement more attractive relative to moving. He argues that increases in income make home improvement less attractive because there are

[7] Estimates of income elasticities for homeowners range from 0.3 in Mendelsohn (1977) to 0.538 in Boehm and Ihlanfeldt (1986). Bogdon (1992) estimates income elasticities for different types of renovations, ranging from 0.15 for roof replacement to 0.84 for new additions.

technical limits to the increase in housing services that can be achieved by making improvements on an existing structure.

Potepan uses the 1979 Panel Study of Income Dynamics, which provides micro level data on households to test his hypotheses by estimating a logit model where the choice is defined as making improvements or moving. His study is limited to the behavior of homeowners. He finds that higher interest rates increase the chances of improving, while increases in income decrease the chances of improving. An increase in interest rates from 2% to 6% increases the probability of choosing to improve from 0.34 to 0.41. Increasing income from $10,000 to $40,000 decreases the probability of improving from 0.36 to 0.32.

Montgomery (1992) argues that Potepan=s results are difficult to interpret because he does not appropriately consider households that choose to do nothing. In one estimated equation households that choose to do nothing are categorized with movers; in another, they are deleted from the sample. Montgomery constructs a model where households choose the optimal level of housing and the means to achieve that level given their current housing such that they maximize utility. Montgomery constructs an ordered probit model where the household choices are defined as moving down (consuming less housing), doing nothing, improving current housing, or moving up (consuming more housing in terms of quantity, quality or both).

Montgomery estimates her model using the 1985 American Housing Survey, which provides detailed information on household and housing characteristics and housing expenditures, including expenditures for renovation and repair. She examines only owner-occupied, single-family detached houses in her analysis. Her results suggest that high income households are more likely to improve than do nothing and will spend more on those improvements than lower income households; as income rises, households are also more likely to

move than improve their existing unit. The probability of improving and the expenditures on improvements are lower for older and minority households as well as for those who have been in their units for a long time. In rapidly growing markets, households are more likely to improve and spend more on those improvements, probably reflecting expectations about house price growth. Occupants of older houses are more likely to improve and also spend more on those improvements.

There is considerably less information on the renovation and repair decisions of investors in rental housing. The literature that does exist is generally based on surveys within a particular geographic area. There have been a few attempts to estimate repair elasticities--the repair response of owners of rental housing to changes in rents. Rydell (1982) reports a repair elasticity of 0.2 based on panel data on rental housing in Brown County, Wisconsin and St. Joseph County, Indiana collected as part of the Experimental Housing Allowance Program (EHAP) Supply Experiment. Rydell (1982) indicates that this estimate is consistent with earlier estimates of repair elasticities of 0.2 to 0.3 by Ozanne and Struyk (1976) based on panel data on renter- and owner-occupied housing in Boston.

Gyourko and Linneman (1990) explore the impact of rent control on the quality of rental housing buildings in New York using the 1968 New York City Housing and Vacancy Survey. This is not a survey of property owners with direct measures of maintenance and renovation. Instead, census surveyors rated the overall quality of the building generally based on visiting common areas, not individual apartments. Gyourko and Linneman conclude that rent control has a substantial negative impact on unit quality, particularly for units in smaller buildings.

From this literature, we can conclude that higher income households are more likely to improve their homes than do nothing, but as incomes rise, households are also more likely to

move. We clearly know more about the renovation and repair decisions of homeowners than those of landlords. We have substantially less evidence on the repair decisions of investors in rental housing. The evidence we do have is largely from the 1970s and indicates that the price elasticity of repairs is quite small. This difference between what we know about renovation and repair decisions of owner-occupants vs. landlords is largely due to the fact that there are micro data available on homeowner expenditures on improvements, but we have little information on the improvement decisions of landlords. The information we do have on landlords is largely the result of the housing experiments funded by the federal government in the 1970s, which is now three decades old. In recognition of the dearth of information on the providers of rental housing, the Census Bureau recently conducted the Property Owners and Managers Survey (POMS), which surveyed the property owner (or their agent) for a sample of 16,300 rental housing units in 1996. The survey includes questions on maintenance and changes to the property structure. These data may help to fill the gap in our understanding of the investment decisions of rental property owners.

Impact of Government Policy on Housing Supply

The federal government has provided extensive subsidies to housing consumers as well as to housing producers over the past six decades. Demand side subsidies or subsidies to consumers have included housing vouchers and certificates designed to increase household purchasing power in the rental housing market, and the deductions from income of mortgage interest and real estate taxes for federal income tax purposes for homeowners. Clearly, such subsidies are expected to increase demand for housing, and that increase in demand should increase rents or prices, which may in turn stimulate new construction. The impact on

construction depends on the size of the increase in rents or prices and the price elasticity of supply.

For the purposes of this overview, I focus on the impact of subsidies directly targeted at housing producers, ignoring the impacts of demand side subsidies such as the mortgage interest deduction. However, the Experimental Housing Allowance Program (EHAP) Supply Experiment of the 1970s provided a unique opportunity to examine the response of suppliers to tenant subsidies. Weicher (1990) argues that subsidies given to low income households are most likely to have an impact on new construction with an entitlement program; the EHAP Supply Experiment was the only housing entitlement program in our history. Rydell (1982) reports that the housing allowance increased demand for rental housing services by 4.6 percent in Green Bay (Brown County) Wisconsin and by 5.6% in South Bend (St. Joseph County) Indiana. He estimates a short run supply elasticity of 0.24 to 0.83 and a long-run supply elasticity of 11.5. Using these estimates, Rydell suggests that the potential increase in rent from the increase in demand is dampened by one-third to one-half because of the supply response in the market. Weicher (1990) indicates that there is no evidence that the supply experiment generated any new housing units in either Green Bay or South Bend. While there was some evidence that landlords did increase maintenance and repairs as shown in Rydell (1982), Weicher points out that it is difficult to draw strong conclusions since there was no information collected on maintenance and repair decisions for unsubsidized units in these markets.

Supply side subsidies are often designed for rental housing and can take many forms. Public housing is new construction financed by the government and owned and managed by local public housing authorities. Private providers of rental housing may be subsidized in a variety of ways. Landlords may receive project-based rent subsidies for serving low-income

tenants, developers may receive subsidized financing in return for providing some portion of units to low-income households, and housing may receive favorable tax treatment which encourages housing developers to provide more housing. Today, the Low-Income Housing Tax Credit (LIHTC) program which was created by the Tax Reform Act of 1986 is the major federal supply side program. The LIHTC offers equity investors in rental housing (new or rehabbed) targeted at low- and moderate-income households substantial tax benefits in the form of tax credits.

I focus on two questions concerning government subsidies to housing producers: What is the impact of direct government programs for housing production on the supply of housing? How does tax policy impact the supply of housing? The fundamental concern with production programs (public housing and subsidized private housing) is the extent to which these programs increase the size of the rental housing stock or simply displace private new construction. Murray (1983) addresses the displacement issue by examining the impact of subsidized private housing, which he terms moderate-income housing, on the housing stock using quarterly data covering 1961-1977. He concludes that these subsidized private housing programs yielded no net additions to the stock, which means that virtually all units created under these programs replaced unsubsidized starts.[8] Murray (1983) also analyzed the impact of public housing on housing supply and found that public housing increases the housing stock; three-quarters of public housing units represented additions to the stock while one-quarter displaced private construction.

Murray (1994) revisits the issue of the impact of subsidized housing units on the stock of housing, using a longer time series covering 1935-1987 and employing more sophisticated time series methods. This study largely reaches the same conclusions as the previous one. It shows

[8] Swan (1973) draws the same conclusion from his analysis of subsidized units for moderate-income households.

that public housing has steadily increased the stock of housing since the program began in 1935, while moderate income housing production programs between 1960 and 1987 added little to the total housing stock. Murray (1994) argues that publicly subsidized new construction for moderate-income households generates vacancies in the unsubsidized housing stock in this market segment. The filtering of these vacancies into the market effectively crowds out private new construction.[9] In the case of public housing, Murray argues that single parent households and elderly households make up a large portion of public housing residents. To the extent that in the absence of public housing these households would "double-up" with parents or children, Murray argues that public housing would have less of an impact on private new construction. In addition, public housing generally serves a lower income population that may not be able to pay rents high enough to bring forth private new construction. If private new construction does not serve this market segment, we would expect that public housing would represent additions to the stock.

Federal tax policy can have an important impact on housing supply by altering the pre-tax return required by investors. While tax policy clearly has a significant impact on the demand for homeownership and owner-occupied housing, here I focus on the impact of tax policy on investors in rental housing. Tax policy sets the rate at which rental income will be taxed, determines the method by which housing assets can be depreciated for tax purposes, defines tax life, which is the period over which the asset is depreciated, and sets the rate at which any capital gains from the property will be taxed.[10] As shown in DiPasquale and Wheaton (1996), the asset price of a rental housing building is equal to the present discounted value of the rental income

[9] There is an extensive literature on filtering in urban housing markets (see Sweeney (1975) and Ohls (1975)).

[10] In the case of the LIHTC, equity investors receive a flow of tax credits over ten years in addition to the other tax benefits given to investors in rental housing not developed through the LIHTC

stream plus the present discounted value of depreciation benefits to the investor plus the present value of the proceeds from selling the building at the end of the holding period after the tax paid on capital gains. The capitalization rate or the cost of capital to investors in rental housing is the ratio of current rent to this asset price.

In DiPasquale and Wheaton (1992), we show that between 1981 and 1986, under the Economic Recovery Tax Act, real estate including rental housing enjoyed very favorable tax treatment with accelerated depreciation, a 15- to 19 year tax life, high marginal income tax rates that increased the value of tax benefits, and a low capital gains tax rate. The Tax Reform Act of 1986 considerably decreased this favorable treatment by moving to straight-line depreciation, increasing the tax life to 27.5 years, and increasing the capital gains tax rate. In addition, any tax benefits were worth less to investors because marginal tax rates declined.[11] Our empirical results suggest that a one percentage point increase in the cost of capital to investors in rental housing results in a 14% decrease in rental housing construction.

Follain, Leavens, and Velz (1993) also find a significant negative relationship between the cost of capital to investors and multifamily rental housing construction. They estimate a short-run elasticity of construction with respect to user costs of -0.39 and a long-run elasticity that is roughly equal to one.

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program.

[11] We estimate that under ERTA, 88% of value was depreciated by year 13, while under Tax Reform, only 47% was depreciated by year 13. The changes under Tax Reform increased the cost of capital to investors in rental housing by four percentage points; one percentage point was due to less favorable depreciation rules while three percentage points were due to the drop in marginal tax rates and the increase in capital gains tax rates.

Conclusions and Future Prospects

It is clear that there has been a considerable amount of work done on housing supply. The evidence presented in this paper suggest a number of conclusions about housing supply:

- New supply does appear to be elastic with respect to price.
- Higher income homeowners are more likely to improve their homes than do nothing. However, as income rises homeowners are more likely to improve their housing by moving than by improving their current unit. Repair and renovation expenditures are inelastic with respect to income and price.
- Subsidizing developers to produce rental housing for moderate-income households tends to displace private construction and as a result generates no increase in the housing stock. Public housing for low-income households has increased the stock of housing.
- Tax treatment of investors in rental housing alters the cost of capital to investors and can have a significant impact on the level of new construction.

The work to date on housing supply leaves some difficult puzzles. In the literature on the determinants of new supply, price does not appear to be a sufficient statistic in determining new construction; the importance of other market indicators such as time to sale and inflation and the unimportance of construction costs are difficult to explain. These anomalies persist across many studies using aggregate data at the national or metropolitan level and employing a variety of time series methods. Much of the work on new supply has focused on the new supply of single family owner occupied housing. We know much less about the determinants of new supply of multifamily rental housing. At this point, I believe that we need to build our understanding of the micro foundations of housing supply. We need to understand how suppliers make decisions and view the marketplace. This work requires data where the unit of observation is the builder or developer, which will be costly to assemble.

We have a considerable amount of information on the repair and renovation decisions of homeowners due to the data provided by various household surveys including the American Housing Survey. The micro information about the maintenance, repair and renovation decisions of landlords in the literature is largely based on data that is three decades old. The new Property Owners and Managers Survey may provide an important base to improve our understanding of how the existing stock of rental housing changes with changes in market conditions.

The housing stock is an important asset in our economy and its value is a substantial part of the nation=s wealth. Understanding the supply of housing is crucial to understanding this market. At this point, we need to know more about the decision-making processes of builders, investors and landlords. Researchers considering work in this area should focus on bringing new data to bear on the decision making of these important actors in determining housing supply.

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